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A Comparison of the Hereford and Charolais Breeds and Their Crosses Under Two Systems of Management

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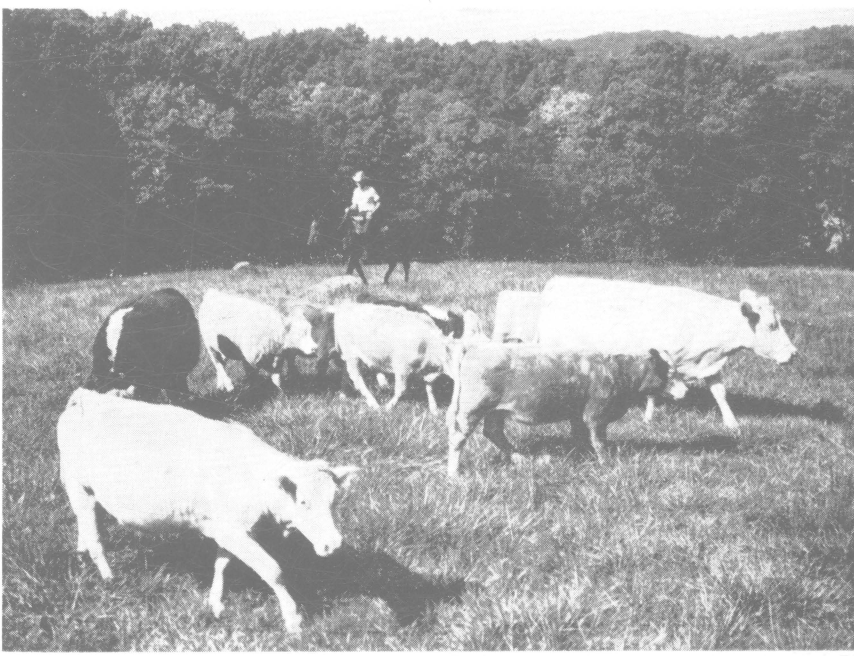

OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER
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CONTENTS

* * *

Introduction - - - 3

Objectives - - - 4

Procedure - - - 4

Results - - - 6

Discussion - - - 18

Summary - - - 19

Literature Cited - - - 21

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A Comparison of the Hereford and Charolais Breeds and Their Crosses Under Two Systems of Management

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INTRODUCTION

Within breeds or types of cattle, a positive relationship exists between rate of gain and efficiency of feed utilization (8, 12). It has also been reported (9) that selection for rate of gain will increase mature size as well as efficiency of gain and, although selection for mature size would be expected to increase rate of gain, it would not substantially improve feed efficiency. Much of the research conducted to compare different sizes of cattle has been within specific breeds (7, 10, 11). In some instances (13), there was considerable variation within each size group. Thus, the research reported here was designed to compare two breeds which are clearly different in size.

The Hereford is a well-established breed of conventional size. The Charolais is a large type, French breed which was just being introduced into the Corn Belt when this research project started in 1957. Little research data were available on the comparative value of these breeds or

Hereford and Charolais cows, straightbred and crossbred calves in breeding and management study at Southeastern Branch, Ohio Agricultural Research and Development Center.

their crosses. Because of their difference in size, it seemed possible that the value of the two breeds might differ depending upon the system of management followed and the age at which the cattle were slaughtered.

The amount of information available on the effects of heterosis on performance traits of beef cattle has been limited. This is especially true of crosses involving the Charolais breed.

The feed required to maintain a beef cow for 1 year must be charged against her calf. The heavier the calf becomes, the smaller this requirement is in proportion to the total feed required to produce a given weight of slaughter beef. On the other hand, young animals utilize their feed more efficiently than older animals. Thus, two opposing forces are operating in determining what age or weight of cattle can be produced more efficiently. Little controlled research data have been available to answer this question when the overall feed requirement of the beef herd is considered.

OBJECTIVES

The objectives of this experiment were:

1. To measure the effects of hybrid vigor in crosses of the Charolais and Hereford breeds of cattle.
2. To study the value of these breeds and their reciprocal crosses under two systems of management.
   (a) Calves creep fed, fattened in dry lot, and slaughtered at 12 to 14 months of age.
   (b) Calves not creep fed, wintered, grazed, fattened in dry lot, and slaughtered at 18 to 20 months of age.
3. To compare the overall efficiency of beef production of the previous two systems of management.

PROCEDURE

This experiment was initiated at the Southeastern Branch of the Ohio Agricultural Research and Development Center, Carpenter, in 1958 with the purchase of 25 Charolais cross and 25 Hereford heifer calves. These were bred as yearlings in the spring of 1959. After they had produced two calf crops and were bred for the third time, the cows were transferred in the fall of 1961 to the Mahoning County Farm, Canfield. At the same time, a second group of 25 heifer calves of both breeds was purchased and added to the project at the Southeastern Branch. These cows were also first bred as yearlings to calve at 2 years of age. The results from three calf crops produced by both groups of cows are included in this report.

The Herefords were straightbred, non-registered calves and the Charolais were three-fourths and higher percentage Charolais breeding.

Three calf crops from each group of cows were included in this phase of the experiment.

Matings were made to produce approximately equal numbers of Charolais, Hereford, and crossbred calves. Purebred Hereford and Charolais bulls were used and were changed each year so that a total of six sires of each breed were included in the study. Approximately half of the crossbred calves were sired by Charolais bulls out of Hereford dams and the other half by Hereford bulls out of Charolais cows. Because of the relatively small number of cattle included, the experiment was not designed to compare the reciprocal crosses.

The cows were wintered in dry lot with access to sheds and were bred to calve in February and March. The weights of all harvested feeds fed to the cows and calves were recorded. Weights of cattle going to and from pasture and the number of days on pasture were also obtained. It was not possible with the facilities available to feed the cows or wintering calves separately by breeds.

At the close of the breeding season in July each year, the calves were divided at random within sex and breeding into two equal groups. One group was creep fed a mixture of equal parts by weight of corn and oats while on pasture with their dams. These calves were fattened in dry lot immediately following weaning. The other group was not creep fed, was wintered to gain 1.0 to 1.25 lb. per head daily, grazed for about 60 days without grain, and then fattened in dry lot. All calves were weaned about November 1 at which time they averaged approximately 260 days of age.

The finishing ration fed in dry lot consisted of mixed hay, soybean meal, and ground ear corn. Silage was not included in the ration since the numbers of deferred cattle fed in the summer were too small to keep silage of good quality in the concrete stave silos available. The calves were fed in groups according to breeding and sex.

In the second phase of this experiment now underway, all heifer calves are retained for breeding. They are bred to Angus bulls and are thus used to compare the breeds and their crosses and to measure the effects of hybrid vigor on mothering ability. Results of this final phase will be presented in a later publication. Steer calves produced during the second phase at the Mahoning County Farm were taken to the Southeastern Branch at weaning time and fattened with the creep fed steer calves produced at that location.

Except for a limited number of heifers which were retained for replacements, all calves were slaughtered through the Meat Laboratory, The Oho State University. Detailed carcass data were obtained which included a separation of half of the carcass into edible portion, fat trim, and bone. Edible portion is defined as muscle tissue with a maximum of ⅜ inch of fat on any surface. Broiled steaks were also evaluated for tenderness by a trained taste panel.

Statistical analyses of results were by the method of least squares (3). In these analyses, the average weight of the dam was included as an independent continuous variable in order to study the relationship between weight of cow and performance traits of her calf. This cow weight was an average of monthly weights taken throughout the year except when omitted during the calving season.

RESULTS

Complete results including detailed carcass cutout data were obtained on a total of 212 calves. Thirty different traits were measured on each of these animals and were subjected to statistical analyses. These analyses measured simultaneously the effects of breed, years, management system, sex, and interactions among these factors. It is thus possible to measure the statistical significance of differences among specific treatments without these differences being influenced by unequal numbers or differences due to other treatments. For example, breeds can be compared with the effects of year of birth, sex, and management system removed. The means or averages also can be adjusted for these differ-

TABLE 1.—Weights and Gains of Hereford, Charolais and Crossbred Cattle (Adjusted for Differences Among Years, Sex, and Systems of Management).

	Hereford	Charolais	Crossbred	Hereford and Charolais	Advantage of Crossbred
				Average	Percent
Number	71	62	79		
Birth weight, lb.	70.0	83.3	77.4	76.6	1.0
Weaning weight (260 day), lb.	518	645	602	582	3.4
Av. daily gain, birth to wean, lb.	1.58	1.99	1.85	1.78	3.9
Av. daily gain on winter ration, lb.*	1.08	1.21	1.19	1.14	4.4
Av. daily gain on pasture, lb.*	1.21	1.32	1.28	1.26	1.6
Av. daily gain on feed, lb.	2.18	2.36	2.32	2.27	2.2
Final weight, lb.	849	992	955	920	3.8
Per day of age	1.62	1.91	1.84	1.77	3.8
Final age, days	523	519	518	521	—

*Includes only 106 cattle which were wintered and pastured prior to going on feed.

ences. Adjusted means of the several variables studied are presented in Tables 1 through 4.

A measure of hybrid vigor compares the performance of the crossbred animal to the average of the two parent breeds. This comparison has been made in Tables 1 and 2. Although not large, there appears to be some consistent hybrid vigor in crosses between the Hereford and Charolais breeds. As shown in Table 1, the final weight of crossbred steers averaged 955 lb. or 3.8 percent heavier than the 920 lb. which might be expected based on the average of Charolais and Hereford.

TABLE 2.—Carcass Traits of Hereford, Charolais and Crossbred Cattle (Adjusted for Differences Among Years, Sex, and Systems of Management).

	Hereford	Charolais	Crossbred	Hereford and Charolais	Advantage of Crossbred
				Average	Percent
Number	71	62	79		
Age at slaughter, days	523	519	518	521	—
Slaughter weight, lb.	849	992	955	920	3.8
Per day of age	1.62	1.91	1.84	1.77	3.8
Carcass weight, lb.	516	615	586	565	3.7
Depth of chest, in.	21.8	23.2	22.9	22.5	1.8
Per day of age	1.00	1.21	1.15	1.10	4.5
Weight edible portion, lb.	363	450	420	406	3.4
Per day of age	.70	.88	.82	.79	3.8
Dressing percentage	60.8	62.0	61.4	61.4	—
Carcass grade*	18.9	17.2	18.2	18.0	1.1
Marbling score†	5.9	4.8	5.4	5.4	—
Fat thickness, in.	.51	.30	.40	.40	—
Tenderness‡	7.0	6.9	6.7	7.0	—
Edible portion, %	70.2	73.2	71.5	71.7	—
Bone, %	14.9	15.9	15.1	15.4	—
Fat trim, %	15.0	10.8	13.3	12.9	3.1
Area rib eye, sq. in.	9.29	11.97	10.97	10.93	3.2
Per cwt. carcass	1.80	1.95	1.87	1.88	—
Weight kidney knob, lb.	15.7	19.1	18.9	17.4	8.6
Per cwt. carcass	3.0	3.1	3.2	3.0	6.7
Carcass length, in.	44.3	48.0	46.6	46.2	0.9
Per cwt. carcass	8.59	7.80	7.95	8.20	—
Length of leg, in.	27.6	30.7	29.3	29.1	0.6
Per cwt. carcass	5.35	4.99	5.00	5.17	—
Depth of chest, in.	21.8	23.2	22.9	22.5	1.8
Per cwt. carcass	4.22	3.77	3.91	4.00	—

*Low average, and high good—16, 17, 18.
†4—slight; 5—small; 6—modest.
‡1—extremely tough to 10—extremely tender.

There were significant differences among breeds in nearly all traits. The Charolais were consistently heavier at birth and weaning, gained more rapidly, and produced heavier carcasses with more edible portion and less fat trim than the Herefords. On the other hand, the Herefords had higher marbling scores and carcass grades than the Charolais. There was only a very small, non-significant difference between the two breeds in tenderness score.

In this experiment, the cattle were slaughtered at a similar age when the Herefords were judged to have reached the low choice grade. The creep fed cattle averaged nearly 14.5 months and the deferred cattle 20 months of age when slaughtered. There was no significant difference among breeds in age at slaughter.

Differences between systems of management were significant for all traits except area of rib eye. There was a highly significant difference in tenderness score between the two systems of management, even though there was less than 6 months' difference in age between them at the time of slaughter. As indicated in Table 4, the younger, creep fed cattle were more tender.

In this experiment, there were no significant differences between steers and heifers in weaning weight, carcass grade, and tenderness score. Other traits measured were significantly different, with the heifers lighter in weight and fatter than steers.

In addition to comparing the two breeds differing in size, the relationship of size to production was also investigated by comparing the

TABLE 3.—Weights and Gains According to System of Management and Sex (Adjusted for Differences Among Breeds and Years).

	Creep Fed, Fattened		Wintered, Grazed, Fattened	
	Steers	Heifers	Steers	Heifers
Number	52	54	63	43
Birth weight, lb.	79.7	74.3	79.4	74.2
Weaning weight (260 day), lb.	641	623	543	547
Average daily gain, lb.				
Birth to weaning	2.02	1.90	1.67	1.64
On winter ration			1.20	1.12
On pasture			1.39	1.15
On feed	2.24	1.93	2.57	2.41
Final weight, lb.	916	834	1020	957
Per day of age	2.11	1.93	1.69	1.58
Final age, days	435	433	605	607

average weight of the dam to the performance of her calf. Highly significant, positive relationships were found between weight of cow and birth weight, weaning weight, final weight, carcass weight, and weight of edible portion produced by her calf. This analyses was among cows within breeds. Thus, the heavier cows within each of the two breeds tended to produce heavier calves. Only those cows whose calves completed the experiment were included in this analyses. So any possible relationship between size of cow and fertility was not considered.

TABLE 4.—Carcass Traits According to System of Management and Sex (Adjusted for Differences Among Breeds and Years).

	Creep Fed, Fattened		Wintered, Grazed, Fattened	
	Steers	Heifers	Steers	Heifers
Number	52	54	63	43
Age at slaughter, days	435	433	605	607
Slaughter weight, lb.	916	834	1020	957
Per day of age	2.11	1.93	1.69	1.58
Carcass weight, lb.	574	521	611	585
Per day of age	1.32	1.20	1.01	.96
Weight edible portion, lb.	417	364	443	420
Per day of age	.96	.84	.73	.69
Dressing percentage	62.7	62.5	59.9	61.1
Carcass grade*	18.4	18.7	17.6	17.8
Marbling score†	5.2	5.8	5.0	5.4
Fat thickness, in.	.41	.47	.35	.40
Tenderness‡	7.3	6.9	6.8	6.6
Edible portion, %	72.7	69.7	72.4	71.7
Bone, %	15.4	14.5	16.3	15.0
Fat trim, %	11.8	15.8	11.2	13.2
Area rib eye, sq. in.	11.1	10.2	10.8	10.8
Per cwt. carcass	1.93	1.96	1.77	1.85
Weight kidney knob, lb.	18.0	20.3	15.3	18.2
Per cwt. carcass	3.1	3.9	2.5	3.2
Carcass length, in.	45.9	44.6	47.6	47.1
Per cwt. carcass	8.00	8.56	7.79	8.05
Length of leg, in.	29.3	28.4	30.1	29.0
Per cwt. carcass	5.10	5.45	4.93	4.96
Depth of chest, in.	22.3	21.7	23.6	22.9
Per cwt. carcass	3.89	4.17	3.86	3.91

*Low, average and high good—16, 17, 18.
†Small — 5, Modest — 6.
‡Extremely tough — 1 to extremely tender — 10.

Results obtained with the first group of cows (4) showed no significant interactions among breeds and systems of management. However, there were two interactions in the second replicate which were significant. There were also a number of significant sex-management system interactions. Data presented in Table 5 are averages for all animals produced by both groups of cows.

Cattle which were creep fed and finished immediately following weaning produced more pounds of edible portion per day of age than those in the deferred system. This was more true of the Charolais than of the Hereford calves (Table 5). This interaction indicates that the rapid growth rate of the large Charolais breed can be utilized best by liberal feeding at a young age.

The other significant breed-management system interaction was in marbling score. The Hereford and crossbred calves slaughtered at the

TABLE 5.—Interactions Between Breed or Sex and Management System.

	Management System	
	Creep Fed	Deferred
Breed x Management System		
Weight edible portion per day, lb.		
Hereford	0.78	0.63
Charolais	1.00	0.77
Crossbred	0.92	0.72
Marbling score*		
Hereford	6.15	5.75
Charolais	4.67	4.86
Crossbred	5.73	5.02
Sex x Management System		
Area rib eye, sq. in.		
Steers	11.1	10.8
Heifers	10.2	10.8
Fat trim, percent		
Steers	11.8	11.2
Heifers	15.8	13.2
Edible portion, percent		
Steers	72.7	72.4
Heifers	69.7	71.7
Weight edible portion per day, lb.		
Steers	0.96	0.73
Heifers	0.84	0.69
Carcass length, in.		
Steers	45.9	47.6
Heifers	44.6	47.1

*Slight — 4, Small — 5, Modest — 6.

younger age had higher marbling scores than those on the deferred system, while the reverse tended to be true with the Charolais calves.

There were several significant interactions between sex and management system (Table 5). In general, differences between heifers and steers became smaller with increased age or with the deferred management system. Although heifers tended to fatten at a younger age, as indicated by the percentage of fat trim, they also appeared to make more growth between 14 and 20 months of age as shown by increases in area of rib eye and carcass length. These differences resulted in a more desirable percentage of edible portion in heifer carcasses produced by the deferred system, while the reverse was true with steer carcasses. The smaller decrease in weight of edible portion per day of age with increased age of heifers suggests they would be more desirable than steers for the deferred system of management.

There were a few significant interactions among years and systems of management. These were in weaning weight and measures of fatness in the carcass, indicating primarily a greater response to creep feeding in some years. Creep feeding was of more benefit when the dams were 2-year-old, first-calf heifers and also during the drier years when pastures were not as abundant.

Average results obtained when the cattle were finished in dry lot are presented in Tables 6 and 7. The first calf crop was separated into groups according to breed but steers and heifers were fed together. For the remaining 5 years, steers and heifers of each breeding group were fed in separate pens. The average difference between steers and heifers in each breed for these 5 years was used to estimate feed consumption and efficiency for the steers and heifers fed the first year. Steers from the second phase of the experiment at the Mahoning County Farm were taken to the Southeastern Branch and fed with the creep fed calves produced there. Daily rations and feed requirements given in the tables are weighted averages of these six groups from each of the two management systems. The average daily gains given are adjusted means from the least squares analyses. The creep fed calves were fed in dry lot for an average of 177 days and the deferred cattle for 110 days.

Analyses of variance of the amount of total digestible nutrients (TDN) required per hundredweight of gain showed highly significant differences between steers and heifers and between the two systems of management. Differences in feed efficiency between breeds were not significant.

Charolais cattle gained more rapidly but also ate more feed per head daily than the Herefords. So there was no significant difference between them in the amount of feed required per unit of gain. The

TABLE 6.—Average Results of Creep Fed Calves Finished Following Weaning* (Average 6 Years).

	Hereford		Charolais		Crossbred	
	Steers	Heifers	Steers	Heifers	Steers	Heifers
Number	33	16	37	15	50	24
Average initial weight, lb	470	492	616	610	583	547
Average final weight, lb.	838	797	1037	955	1022	891
Average daily gain, lb.	2 05	1 82	2 27	2 04	2 28	2 05
Average daily ration						
Ground ear corn, lb.	12 3	12 2	15 4	14 3	15 5	13 3
SBOM, lb	1 5	1 5	1 5	1 5	1 5	1 4
Hay, lb	2 1	2 1	2 1	2 2	2 1	2 2
Feed per cwt gain, lb:						
Ground ear corn, lb.	586	678	644	712	628	661
SBOM, lb	69	81	60	74	58	70
Hay, lb.	101	119	88	110	86	109
TDN per cwt. gain, lb.:						
Total, maintenance and gain	532	618	561	632	547	592
Gain, total minus maintenance	256	311	263	315	257	294

*Includes steers from Phase 2 at Mahoning County.

TABLE 7.—Average Results of Cattle Finished Following Wintering and Pasture (Average 6 Years).

	Hereford		Charolais		Crossbred	
	Steers	Heifers	Steers	Heifers	Steers	Heifers
Number	24	13	21	10	18	20
Average initial weight, lb.	703	674	877	820	835	772
Average final weight, lb.	978	949	1175	1073	1114	1037
Average daily gain, lb.	2.54	2.30	2.67	2.44	2.60	2.37
Average daily ration:						
Ground ear corn, lb.	18 0	16.7	19.6	19.7	19.9	18.3
SBOM, lb.	1.4	1.4	1.4	1.4	1.4	1.4
Hay, lb.	2.3	3.0	2.6	2.4	2 4	2.8
Feed per cwt. gain, lb.:						
Ground ear corn, lb.	738	723	770	819	782	802
SBOM, lb.	58	61	53	58	57	62
Hay, lb.	95	127	103	100	93	115
TDN per cwt. gain, lb.:						
Total, maintenance and gain	631	639	655	693	662	693
Gain, total minus maintenance	362	349	355	384	370	388

TABLE 8.—Calving Percentages and Difficulties.

Sire Dam	Hereford Hereford	Charolais Charolais	Hereford Charolais	Charolais Hereford
Number cows bred	98	107	55	54
Number calves born	84	93	49	48
Percent born, of cows bred	86	87	89	89
Number cows helped calve	9	13	3	16
Number requiring veterinarian	2	1	—	3
Percent helped, of calves born	11	14	6	33
Number calves weaned	78	78	45	39
Percent weaned, of cows bred	80	73	82	72
	Straightbred		Crossbred	
Number cows bred	205		109	
Number calves born	177		97	
Percent born, of cows bred	86		89	
Number calves weaned	156		84	
Percent weaned, of cows bred	76		77	

Charolais were considerably heavier than the Herefords and hence had more weight to be maintained. This would increase the amount of feed required for maintenance and possibly leave a smaller proportion of the amount consumed for the production of gain.

To study the amount of TDN required per unit of gain after maintenance needs had been met, the amount of TDN required for maintenance was subtracted from the total. This amount was determined by the equation: lb. TDN $= 0.036\ W^{0.75}$ (W $=$ weight in lb.), as published by Garrett, Meyer and Lofgreen (2). A weight near the average for the feeding period was used to calculate these maintenance needs. When the maintenance requirement was subtracted from the total TDN, there was only a very small difference between breeds in the amount of TDN required per hundredweight of gain. There appeared to be no heterosis in this TDN utilization.

Some calving difficulty may be expected with first-calf heifers. This is especially true when they are bred as yearlings to calve at 2 years of age. In this experiment, all heifers were bred as yearlings and half of the crossbred calves produced were from Hereford heifers bred to Charolais bulls. Calving percentages obtained and calving difficulties encountered are presented in Table 8.

There were only small differences between the breeds and crosses in number of calves born as a percentage of cows in the herd at breeding time. Charolais cows appeared to wean a smaller percentage of calves than Herefords when bred straight but a higher percentage when crossed. Thus, there was very little difference between them. Slightly higher calving percentages were obtained from crossbred matings than from straightbreds.

The most calving trouble was encountered when Hereford heifers were bred to Charolais bulls. However, more than 80 percent of the total number of calving difficulties involved were first-calf, 2-year-old heifers. Only limited calving problems were experienced following this first calf, regardless of the breed or cross. Only one Caesarean section was required and that was a Hereford heifer bred to a Hereford bull.

The breeds were fed separately in the finishing lot but it was not possible to maintain the breeds of cows as separate herds or to feed the wintering calves by breed groups. Thus, it is not possible to compare the overall, total feed efficiency of the two breeds. However, the two breeds and their crosses were equally represented in the two systems of management and therefore the creep feeding, early finishing system can be directly compared to the deferred system.

Feed records of the dams were initiated during the fall after the heifers were bred for the first time. All feed consumed for the following

TABLE 9.—Total Digestible Nutrients Required to Produce a Unit of Beef Under Two Systems of Management.

Replicate I

	Creep Fed, Fattened			Wintered, Grazed, Fattened		
	1959 to 1961	1960 to 1962	1961 to 1963	1959 to 1961	1960 to 1962	1961 to 1963
		Pounds				
TDN required per head to:						
Winter cow	927	1609	2156	927	1609	2156
Pasture cow	1798	2002	1107	1798	2002	1107
Pasture calf	772	895	893	1024	1143	961
Creep feed	516	295	430	—	—	—
Winter calf	—	—	—	1441	1252	1524
Pasture yearling	—	—	—	634	755	543
Fatten in dry lot	2065	2251	2540	1886	1695	2242
TDN required to weaning	4013	4801	4586	3749	4754	4224
Weaning weight	566	537	613	475	520	489
TDN per cwt	709	894	748	789	914	864
Percent required by cow	68	75	71	73	76	77
Total TDN	6078	7052	7126	7710	8456	8533
Final weight	913	909	996	1015	1051	1124
TDN per cwt.	666	776	716	760	805	759
Percent required by cow	45	51	46	35	43	38

year was charged against the calf produced during that year. The weights of all harvested and purchased feeds fed to the cows and calves were recorded. These weights were converted to pounds of TDN. From the number of days on pasture, average weights, and average gains during the pasture season, the amount of TDN obtained from pasture was estimated from theoretical requirements for maintenance and gain. The formula used to make these pasture estimates was published by Garrett, Meyer and Lofgreen (2) and is:

$$TDN = 0.036\ W^{0.75}\ (1 + 0.57\ \text{gain}).$$

The gain made by the suckling calf while on pasture was credited directly to the pasture. A significant but unmeasurable part of this was obtained indirectly from the pasture through the milk produced by the calf's dam. During some dry years, the pastures were supplemented with hay which was credited to the pasture rather than charged to the winter feed.

The results for each replicate and their averages are presented in Tables 9 to 11. In these calculations, the average weight of cow and calf, average feed consumption, etc., were used and hence the data pre-

TABLE 10.—Total Digestible Nutrients Required to Produce a Unit of Beef Under Two Systems of Management.

Replicate II

	Creep Fed, Fattened			Wintered, Grazed, Fattened		
	1962 to 1964	1963 to 1965	1964 to 1966	1962 to 1964	1963 to 1965	1964 to 1966
	Pounds					
TDN required per head to:						
Winter cow	1393	1407	1587	1393	1407	1587
Pasture cow	1482	1790	2233	1482	1790	2233
Pasture calf	734	707	886	955	1112	1172
Creep feed	459	593	397	—	—	—
Winter calf	—	—	—	1393	1298	1383
Pasture yearling	—	—	—	832	433	677
Fatten in dry lot	2446	2270	2052	1754	2364	1662
TDN required to weaning	4068	4497	5103	3830	4309	4992
Weaning weight	548	556	565	463	491	529
TDN per cwt.	742	809	903	827	878	944
Percent required by cow	71	71	75	75	74	77
Total TDN	6514	6767	7155	7809	8404	8714
Final weight	1023	941	929	1038	1025	1090
TDN per cwt.	637	719	770	752	820	799
Percent required by cow	44	47	53	37	38	44

sented in these tables assume a 100 percent calf crop. Thus, the amount of TDN required by the cow would be proportionately higher depending upon the calving percentage realized. The data given in these tables represent nearly 300 cow years.

The amount of TDN required by the cow tended to increase each year in both replicates. This was due to the increased weight associated with increased age. The amount obtained from pasture the third year by the first replicate of cows was lower as the cows lost an average of 34 lb. during the pasture season. During the other five pasture seasons, the cows gained from 39 to 219 lb. per head, with an average gain of 127 lb.

At weaning time, the nutrients required to carry a cow for a year are a high percentage of the total feed needed to produce a unit weight of calf. As indicated in Table 3, these were 72% and 75% for the early and late slaughtered groups, respectively. The remaining nutrients were obtained by the calf from pasture and milk from the dam. The TDN supplied through creep feeding were about 10% of the total to weaning and increased the weaning weight an average of 70 lb. per head. This reduced the total nutrients required per hundredweight of calf from 870

TABLE 11.—Total Digestible Nutrients Required to Produce a Unit of Beef Under Two Systems of Management.

Aveage Results

	Creep Fed, Fattened			Wintered, Grazed, Fattened		
	Rep. 1	Rep. 2	Average	Rep. 1	Rep. 2	Average
TDN required per head to:						
Winter cow	1564	1462	1513	1564	1462	1513
Pasture cow	1636	1835	1736	1636	1835	1736
Pasture calf	853	776	814	1043	1080	1062
Creep feed	414	483	448	—	—	—
Winter calf	—	—	—	1406	1358	1382
Pasture yearling	—	—	—	644	647	646
Fatten in dry lot	2285	2256	2270	1941	1927	1934
TDN required to weaning	4467	4556	4511	4243	4377	4311
Weaning weight	572	556	564	495	494	494
TDN per cwt.	784	818	801	856	883	870
Percent required by cow	71	72	72	75	75	75
Total TDN	6752	6812	6781	8234	8309	8273
Final weight	939	964	952	1063	1051	1057
TDN per cwt.	719	709	714	775	790	782
Percent required by cow	47	48	48	39	40	40

to 801 lb. These data emphasize the importance of the economical feeding of the cow and the value of creep feeding if the calves are to be sold at weaning time.

When slaughtered, the creep fed group required 714 lb. of TDN per 100 lb. liveweight and the non-creep group 782 lb. or approximately 10% more. The non-creep group averaged 105 lb. heavier at slaughter and the percentage of nutrients required by the cow was reduced from 48% to 40% of the total.

The results of these experiments indicate that the creep fed calves which were fattened immediately following weaning produced their weight with the least TDN per unit of weight. However, these cattle obtained 40% of their energy from concentrates (fattening ration plus creep feed) while those slaughtered at an older age required only 23% from the fattening ration. The most beef with the least amount of grain would have been produced by the creep fed calves if they had been slaughtered at weaning time. The creep fed calves more nearly approached a slaughter condition at weaning time than the non-creep calves, which had received no grain prior to weaning. The most profitable system of management would thus be determined by the kind and cost of feed available.

DISCUSSION

Results of this experiment confirm the close positive relationship which has been reported between size and growth rate in beef cattle. The larger Charolais breed produced heavier, faster gaining calves than the smaller Hereford breed. In addition, regression analyses of average weight of dam and performance of her calf indicate that the heavier cows within each breed produced heavier, faster gaining calves.

The relationship between rate of gain and efficiency of feed use, however, was not as definite in this study as has been observed and reported within types or breeds of cattle. When on feed in dry lot, the faster gaining Charolais did not make more efficient gains than the smaller, slower gaining Herefords. With the group feeding system used in this experiment, it was not possible to measure the within-breed correlation between rate and efficiency of gain. The results presented here suggest that the relationship between rate and efficiency of gain between breeds of cattle varying in size may be different from that observed within a breed or breeds of similar size. These observations also confirm the report of Lickley *et al.* (9) that selection for mature size alone may have little effect upon efficiency of gain.

Results published elsewhere (6) indicate that the maintenance requirements of Hereford and Charolais cows are similar when these requirements are based on their metabolic size ($W^{0.75}$). A 1500 lb.

Charolais cow would not need 1.5 times as much feed for maintenance as a 1000 lb. Hereford cow and there would appear to be some advantages associated with the larger animal. In the present experiment, it was not possible to feed the Hereford and Charolais cows separately. Further research is needed to more accurately measure the relationships between size and efficiency of production within breeds and between breeds when the total amount of feed needed by the entire beef herd is included in the measure of efficiency.

The significant interactions obtained between breeds and management systems indicate that certain sizes and/or sexes of cattle may be best suited to fairly specific types of production. The results presented suggest that steers from a large, fast gaining breed, such as the Charolais, would be best adapted to an intensive type of production in which the calves are slaughtered at a young age. Conversely, heifers of a smaller breed would appear to be better adapted to a deferred system in which more time was allowed for maximum development of the muscular system. These results are in agreement with another experiment (5) in which there appeared to be a difference between heifers and steers in their ability to make maximum use of corn silage in a finishing ration.

SUMMARY

Three calf crops were produced by each of approximately 50 Hereford and 50 Charolais (3/4 and higher percentage Charolais) females. These cows were bred to purebred Hereford and Charolais bulls to produce approximately equal numbers of Hereford, Charolais, and crossbred calves. Half of the calves were creep fed, fattened immediately following weaning, and slaughtered at slightly more than 14 months of age. The other half were not creep fed, were wintered, grazed for about 60 days, fattened in dry lot, and slaughtered at about 20 months of age. Weights of all harvested and purchased feeds fed to the cows and calves were recorded. All finished cattle were slaughtered in the Meat Laboratory, The Ohio State University, where half of the carcass was separated into edible portion, fat trim, and bone. Results obtained were analyzed by the method of least squares.

When slaughtered at similar ages, there were highly significant differences among breeds in many traits measured. Charolais calves were heavier at birth and weaning, gained more rapidly, and produced heavier carcasses with more edible portion and less fat trim than the Herefords. Hereford carcasses had higher marbling scores and grades than the Charolais. There was no significant difference between the two breeds in tenderness of broiled steaks.

There was a small but consistent amount of heterosis in growth of the crossbred calves. Increases in gain and final weight were about 4

percent. There was little heterosis expressed in carcass traits except that the crossbreds tended to be fatter than the average of the Hereford and Charolais.

Differences between systems of management were significant for all traits except area of rib eye. Steers and heifers were not significantly different in weaning weight, carcass grade, or tenderness score. Other traits measured were significantly different, with the heifers being lighter in weight and fatter than steers.

There were significant breed-management system interactions in weight of edible portion produced per day of age and in marbling scores. Charolais calves produced more edible portion per day of age than Hereford calves and this difference was greater when they were creep fed than when managed by the deferred system. Hereford and crossbred calves slaughtered at the younger age had higher marbling scores than those on the deferred system, while the opposite was true with the Charolais calves.

There were significant sex-management system interactions in area of rib eye, percentage and weight of edible portion, percentage fat trim, and carcass length. Heifers produced by the deferred system had a higher percentage of edible portion and the reverse was true with steer carcasses. Although heifers were fatter at the younger age, they appeared to grow more than steers in area of rib eye and carcass length between 14 and 20 months of age.

Creep feeding increased weaning weight and final condition more when the dams were 2-year-old, first-calf heifers than when the cows became more mature. It was also more beneficial during the drier years when pastures were not as abundant.

Differences in efficiency of feed utilization between breeds while on feed in dry lot were not significant. This was also true when an adjustment was made for the higher maintenance needs of the larger Charolais and crossbred cattle. There was no apparent hybrid vigor in amount of feed needed to produce a unit of gain.

Most of the calving difficulties were encountered with 2-year-old heifers, with Herefords bred to Charolais bulls the most troublesome. However, only limited calving problems were experienced following this first calf regardless of the breed or cross. Only slightly higher calving percentages were obtained from crossbred matings than from straightbred.

When the amount of TDN required to maintain the cow was included, the calves which were creep fed and finished immediately following weaning required the least TDN per unit of slaughter weight. However, these cattle obtained 40 percent of their energy from concentrates (creep feed and finishing ration), while those slaughtered at an older age required only 23 percent. The most efficient system would appear to be the production of a maximum weight of slaughter grade beef at weaning age.

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